



National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 3171a

Multielement Mix A-1 Standard Solution

Lot No. 890908

This Standard Reference Material (SRM) is intended primarily for use in calibrating instruments used in atomic spectrometry, including atomic absorption spectrometry, inductively coupled plasma optical spectrometry, and inductively coupled plasma mass spectrometry. It can also be used in conjunction with any other analytical technique or procedure where an aqueous standard solution is required. One unit of SRM 3171a consists of 50 mL of a multielement solution in a high density polyethylene bottle in an aluminized bag. The solution is prepared gravimetrically to contain known amounts of 13 elements in an approximate nitric acid volume fraction of 10 %, with trace amounts of hydrochloric acid and hydrofluoric acid.

The certified values (Y) given in Table 1 are based on: (1) gravimetric preparation and (2) inductively coupled plasma optical emission spectrometry (ICP-OES) using three independently prepared primary gravimetric solutions. Each certified value has been adjusted upward by 0.1 % relative to compensate for the effect of transpiration losses of solvent through the container walls during the period validity of the *unopened* SRM. *No correction has been applied for transpiration that will occur after the SRM bottle unit has been removed from the sealed bag.* See “Instructions for Use” for more information regarding transpiration.

The uncertainty in the certified value is calculated as

$$U = (ku_c + 0.001Y + B) \text{ mg/g}$$

where k is the coverage factor, u_c is the combined standard uncertainty, $0.001Y$ is the uncertainty of the transpiration correction, and B is an allowance for method bias. The coverage factor, $k = 2.0$, is the Student's t -value for a 95 % confidence interval. The combined standard uncertainty, u_c , has been calculated according to the ISO Guide [1] and is intended to represent, at the level of one standard deviation, the combined effect of uncertainty components associated with gravimetric preparation and the ICP-OES measurement. The maximum increase in concentration due to transpiration predicted to occur in unopened bottles of the SRM over the period of validity is 0.2 %. Accordingly, a correction of $+0.001Y$ has been applied, with an uncertainty of $\pm 0.001Y$. The allowance for method bias, B , has been calculated according to the procedure of Schiller and Eberhardt for combining independent analytical methods [2].

Expiration of Certification: The certification of **SRM 3171a Lot No. 890908** is valid, within the measurement uncertainty specified, until **01 September 2001**, provided the SRM is handled in accordance with instructions given in this certificate (see Instructions for Use). This certification is nullified if the SRM is damaged, contaminated, or modified.

Maintenance of Certification: NIST will monitor representative solutions from this SRM lot over the period of its certification. If substantive changes occur that affect the certification before the expiration of certification, NIST will notify the purchaser. Return of the attached registration card will facilitate notification.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the NIST Standard Reference Materials Program by N.M. Trahey.

Willie E. May, Chief
Analytical Chemistry Division

Gaithersburg, MD 20899
Certificate Issue Date: 09 August 2000
See Certificate Revision History on Last Page

Nancy M. Trahey, Chief
Standard Reference Materials Program

Coordination of the technical measurements leading to the certification of SRM 3171a was provided by G.C. Turk of the NIST Analytical Chemistry Division. This SRM was prepared by T.A. Butler and analyzed using ICP-OES by M.L. Salit and A.P. Lindstrom of the NIST Analytical Chemistry Division. Primary standards for ICP-OES calibration were prepared by B.R. Norman of the NIST Analytical Chemistry Division.

Statistical consultation was provided by K.R. Eberhardt of the NIST Statistical Engineering Division.

Table 1. Certified Values (*Y*) for SRM 3171a

Element	Mass Fraction ($\mu\text{g/g}$)
Aluminum	96.8 \pm 1.1
Antimony	99.2 \pm 1.1
Beryllium	10.2 \pm 0.2
Cadmium	98.9 \pm 2.1
Chromium	98.7 \pm 0.9
Iron	101.0 \pm 1.0
Magnesium	79.6 \pm 0.8
Manganese	98.2 \pm 2.1
Molybdenum	101.4 \pm 0.7
Nickel	102.2 \pm 0.8
Potassium	495.9 \pm 4.8
Sodium	99.3 \pm 1.0
Vanadium	99.0 \pm 0.9

TRACEABILITY TO THIS SRM

Calibration of analytical instruments or procedures for the determination of the 13 elements listed above should be performed using standards that are traceable to this SRM. The traceability of standards to this SRM must be established through an unbroken chain of comparisons, each having stated uncertainties [3]. Comparisons are based on physical or chemical measurements proportional to the element concentrations. These may include various spectroscopic or classical methods of analysis. Gravimetric or volumetric dilution is also a method of comparison, where the mass or volume of a solution before and after dilution is measured. The uncertainties assigned to such traceable standards must include the uncertainty of this SRM appropriately combined with the uncertainties of all comparison measurements.

INSTRUCTIONS FOR USE

This SRM can be used to prepare *working standard solutions* in the range of 10 mg/kg to 100 mg/kg, from which more dilute standards are prepared. The user should establish internal laboratory procedures that specify a maximum shelf life for a working standard solution. Two procedures for the preparation of working standard solutions follow.

Preparation of Working Standard Solutions by Mass: Each working standard solution should be prepared by transferring an aliquot of the SRM to an empty, dry, preweighed polyethylene bottle, and then re-weighing the bottle. An appropriate dilute acid must be added by mass to bring the solution to the approximate desired dilution. The dilution need not be exact since the mass of the empty bottle, mass of the bottle plus SRM aliquot, and the final diluted mass of the solution will permit calculation of the exact concentration of the working solution. Dilutions prepared gravimetrically as described will need no correction for temperature and no further correction for true concentration in vacuum. The working standard solution concentration will be in mg/kg units. Volumetric dilutions are **NOT** recommended due to uncertainties in volume calibrations and variations in density. However, for user convenience, a procedure for volumetric preparation that will minimize the major sources of error is given below.

Preparation of Working Standard Solutions by Volume: Each working standard solution should be prepared by transferring an aliquot of the SRM to an empty, dry polyethylene bottle and then weighing the bottle. The solution must now be transferred to a Class A volumetric flask and the polyethylene bottle re-weighed to determine the exact mass of SRM solution transferred. The solution in the flask is then diluted to 99 % + of volume using an appropriate dilute acid, mixed thoroughly, and the remaining few drops needed to dilute to exact volume carefully added. The concentration (in mg/mL) of the resulting working standard solution can then be calculated by

multiplying the mass (in g) of the SRM solution amount by the SRM certified value (in mg/g), and dividing the numerical product by the calibrated volume (in mL) of the flask used for dilution. Thus, no correction for density is needed, and although the concentration of the resulting working standard solution may be an uneven fraction of the original SRM concentration, it will be known as accurately as a volumetric dilution permits.

Transpiration: After the SRM has been removed from the aluminized bag, transpiration will occur at an accelerated rate of approximately 0.2 % relative per year, resulting in a gradual increase in the element mass fraction. It is the responsibility of the user to account for this effect. The recommended way to reduce the effects of transpiration is to begin the preparation of all working standard solutions by delivering weighed aliquots of the SRM to appropriate vessels as soon as the SRM is removed from the aluminized bag. The aliquots may be stored and can be diluted to known mass or volume at a later date. Storage of a partially used SRM bottle is **NOT** recommended; however, if such storage is necessary, the cap should be tightly sealed and the SRM bottle kept in an airtight container to slow the rate of transpiration. When the bottle is weighed both before and after being placed in storage, the mass difference observed will be a measure of transpiration mass loss. The user should set a maximum shelf life for a partially used SRM bottle commensurate with accuracy requirements.

REFERENCES

- [1] *Guide to the Expression of Uncertainty in Measurement*, ISBN 92-67-10188-9, 1st Ed., ISO, Geneva, Switzerland, (1993); see also Taylor, B.N. and Kuyatt, C.E., "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," NIST Technical Note 1297, U.S. Government Printing Office, Washington DC, (1994); available at <http://physics.nist.gov/Pubs/>.
- [2] Schiller, S.B. and Eberhardt, K.R., "Combining Data From Independent Chemical Analysis Methods," *Spectrochimica Acta*, **46B**, pp. 1607-1613, (1991).
- [3] *International Vocabulary of Basic and General Terms in Metrology*, ISBN 92-67-01075-1, 2nd Ed., ISO, Geneva, Switzerland, (1993).

Certificate Revision History: 08 August 2000 (This revision reflects a change in the certification period and editorial changes.); 15 December 1998 (original certificate date).

Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-6776; fax (301) 926-4751; e-mail srminfo@nist.gov; or via the Internet <http://www.nist.gov/srm>.